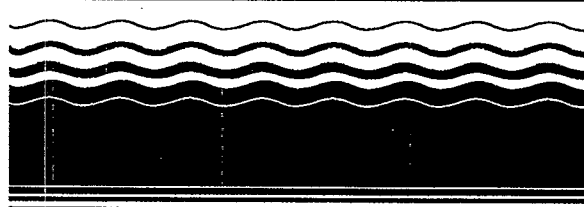




# SITE

SUPERFUND INNOVATIVE  
TECHNOLOGY EVALUATION



## Demonstration Bulletin

### *In Situ Vitrification*

#### *Geosafe Corporation*

**Technology Description:** In Situ Vitrification (ISV) is designed to treat soils, sludges, sediments, and mine tailings contaminated with organic and inorganic compounds. The process uses electrical current to heat (melt) and vitrify the soil in place. Organic contaminants are decomposed by the extreme heat into simple gases, which then rise through and escape from the molten soil. Inorganic contaminants are trapped within the molten soil, which cools and solidifies into a glassy monolith.

The ISV technology demonstrated by Geosafe Corporation (Richland, Washington) operates by means of four graphite electrodes, arranged in a square, and inserted into the soil to be treated. A pattern of electrically conductive graphite containing glass frit is placed on the soil in paths between the electrodes. When power is fed to the electrodes, the graphite and glass frit conducts the current through the soil, heating the surrounding area and melting directly adjacent soil. Molten soils are electrically conductive and can continue to carry the current which heats and melts soil downward and outward. The electrodes are allowed to progress down into the soil as it becomes molten, continuing the melting process to the desired treatment depth. As treatment progresses, a "cold cap" of solidified material forms at the surface. When all of the soil in the treatment area becomes molten, the power to the electrodes is discontinued and the molten mass begins to cool. The electrodes are cut near the soil surface and are allowed to settle into the molten soil to become part of the melt. (One setting of four electrodes is referred to as a "melt.") After the molten soil cools a glass and crystalline vitrified material remains.

The organic contaminants in the soil undergoing treatment are pyrolyzed (heated to decomposition without oxygen) and are generally reduced to simple gases. The gases migrate through the molten soil and/or the adjacent dry zone to the surface, often following the path of the electrodes where the mass is least viscous. Gases at the surface are collected in a stainless steel hood placed over the area being treated. The hood is hexagonal and approximately 60 ft (18 meters) in diameter. It is sealed at the soil surface with clean fill and kept at a negative pressure during treatment to prevent the gases from escaping out of the system. Gases from the hood are treated in an off-gas treatment system, comprising a quencher, a scrubber, a demister, HEPA filters for particulates, and activated carbon adsorption to process the off-gas before releasing the cleaned gas through a stack. A thermal oxidizer can be used after the off-gas treatment system, if necessary, to polish the off-gas before release to the atmosphere. A generator-run back-up gas treatment system is also

connected to the hood, and is designed to be activated automatically in case of power interruption.

Inorganic contaminants in the soil are generally encapsulated in the molten soil which hardens to a vitrified mass that has characteristics similar to volcanic obsidian. The vitrified soil is dense and hard, and significantly reduces the possibility of leaching from the mass over the long term. Since the vitrification process removes most of the void space in the soil, as well as destroys the organic contamination, a volume reduction of 20 to 50% is achieved by the technology, leaving a subsidence volume at the top of the treated block. This volume is backfilled with clean soil immediately after treatment.

A large area of contaminated soil is treated by consecutive melts, which are spaced to overlap along the edges and form one continuous monolith. Treatment of each melt occurs at a rate of approximately four to six tons per hour. The melt performed during the Demonstration Test took approximately 10 days to complete.

**Demonstration Approach:** A Demonstration Test of ISV was conducted at the Parsons Chemical Site in Grand Ledge, Michigan. The demonstration was performed in conjunction with cleanup operations occurring at the site under the direction of EPA Region V. Soil at the site was contaminated with low levels of pesticides and mercury. Before treatment with ISV the contami-

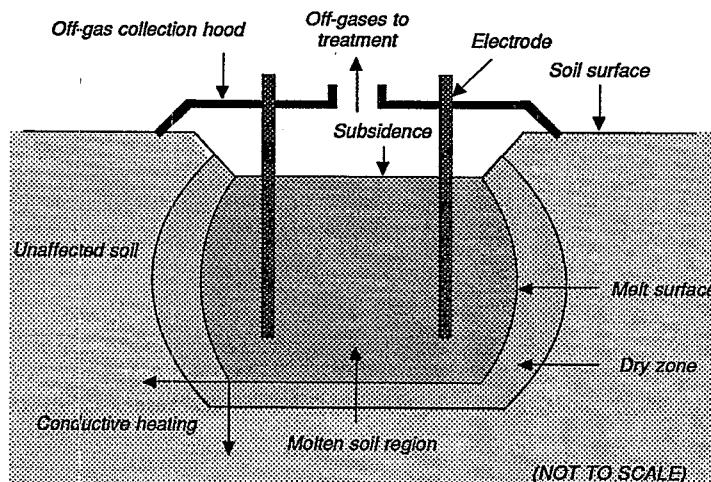


Figure 1. Diagram of an ISV treatment melt.



nated soil was staged in open concrete trenches designed for nine treatment settings. The trenches were lined with cobble and wood, and surrounded by clean soil.

Prior to the Demonstration Test, treatment of the staged areas by the Geosafe ISV system had been ongoing for several months as a part of the Parsons site cleanup action. The Demonstration focused on the treatment of Cell 8. This cell was selected for Demonstration Test sampling by the SITE Program because Region V data indicated that this was the most contaminated cell. This cell was treated relatively late in the melt order to give the developer a chance to shake down and optimize the equipment and procedures before the SITE demonstration.

The effectiveness of the ISV technology was investigated through sampling of solid, liquid, and gas matrices. The soil in the treatment cell was sampled before treatment and analyzed for pesticides and metals. During the test samples of the scrubber water were collected before, during, and after the treatment of Cell 8. Gas samples from the thermal oxidizer stack were collected during treatment of Cell 8 and were analyzed for volatile and semivolatile organic compounds, pesticides, dioxins/furans, metals, HCl, and particulates. Continuous emission monitoring for total hydrocarbons, oxygen, and carbon monoxide was conducted throughout treatment by the developer. After the soil in the Cell 8 was treated by the technology, samples of the vitrified material on the surface were collected and analyzed for pesticides and metals. The TCLP (toxicity characteristic leaching procedure) was also performed on these samples to determine the leachability of pesticides and mercury in the vitrified material. Additional samples of the treated material will be collected after the treated soil has completely cooled and solidified (approximately one year after treatment).

A detailed economic analysis of this full-scale technology application will be performed utilizing collected data (i.e., power usage, labor requirements, waste generation, maintenance needs, etc.). This data was collected by the developer and the SITE program during the course of operation.

**Preliminary Results:** Preliminary evaluation of the post-treatment data suggests the following conclusions:

- The technology treated the soil as expected, completing the melt in 10 days. During this time approximately 330 yd<sup>3</sup> (250 m<sup>3</sup>) of contaminated soil was vitrified according to Geosafe melt summaries. Approximately 613,000kWh of power was applied to the total soil volume during vitrification of Cell 8. This total soil volume exceeds the contaminated soil volume because clean

fill and surrounding uncontaminated soil are treated as part of each melt.

- The cleanup levels specified by EPA Region V for chlordane, 4,4-DDT, dieldrin and mercury were met. Pesticide concentrations were reduced to non-detectable levels in the vitrified soil.
- The solid vitrified material collected was subjected to TCLP for mercury and pesticides. The test results indicated that leachable mercury was well below the regulatory guidelines (40 CFR part 261.24), and no target pesticides were detected in the leachate.
- Samples of the stack gas after the off-gas treatment system were collected during the Demonstration Test to characterize process emissions. There were no target pesticides detected in the stack gas samples. Metal emissions were below regulatory requirements during the Demonstration Test. Continuous emission monitoring of the gas showed that total hydrocarbon and carbon monoxide emissions were in compliance with EPA Region V limits.
- Scrubber water generated during the Demonstration Test contained partially oxidized semivolatile organics (phenolics), volatile organics, mercury, and other metals. The scrubber water required secondary treatment before ultimate disposal.
- The system ran continuously for approximately 10 days with only minor operational problems. System operation was interrupted for routine maintenance such as electrode segment addition and adjustment.

Key findings from the demonstration, including complete analytical results and the economic analysis, will be published in an Innovative Technology Evaluation Report. This report will be used to evaluate the Geosafe ISV technology as an alternative for cleaning up similar sites across the country. Results will also be presented in a SITE Technology Capsule and a videotape.

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